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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/648,750	08/28/2000	Chihiro Uchibori	P108077-00000	6477

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EXAMINER

LEE, GRANVILL D

ART UNIT

PAPER NUMBER

2825

DATE MAILED: 06/06/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/648,750

Applicant(s)

UCHIBORI, CHIHIRO

Examiner

Granvill D Lee, Jr

Art Unit

2825

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 May 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-26 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-26 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 5.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Response to Applicant's Amendment

After review of applicant's amendments and comments, the examiner finds such arguments unpersuasive. Applicant's comments as to Dubin, Kim et al., Venkatraman and Farrar are well taken, however in further review of the prior art, the examiner has found that Dubin, Kim et al., Venkatraman and Nogami et al. read upon applicant's claimed invention. As these are a new grounds for rejection, but because of the amendment submitted these are to be considered final.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-2, 6-7, 13-15, 17, 19, 20, 22 and 26, are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin (US. Pat. 6,249,055) in view of Kim et al. (US. Pat. 4,751,349).

In view of these claims, Dubin discloses a metal interconnection buried in a dielectric layer (Fig. 3 #10) having a barrier layer (Fig. 5 #52) of tantalum nitride (TaN), an interconnect layer (Fig. 54 #54) using copper (Col. 6 lines 50-

55), and an aluminum adhesion layer (Fig. 5 #55). Dubin indicates that a copper seed layer (#56) is also used for adhesive purposes, and can be made of zirconium (Col. 7 lines 40-47). Although, Dubin makes it clear that a zirconium (among others) layer could be used for an adhesion layer (Col. 5 lines 60-67), Kim et al. teaches that zirconium is the main element in a multi-layer metallic structure and is used for adhesion specifically (Abstr.). Because Dubin already teaches use of a copper seed layer, where zirconium is considered, and it was discovered by Kim et al. that superior strength is available when zirconium is used in conjunction with copper (Col. 1 line 64-col. 2 line 5), the use of Kim et al. utilizing the material zirconium merely emphasizes, rather than used in combination of the Dubin teaching.

In view of claims 1, 6 and 14-15, Dubin makes a metal interconnection buried in a dielectric layer having a barrier layer of tantalum nitride (TaN), an interconnect layer using copper (Col. 6 lines 50-55), and an aluminum seed layer which can act as an adhesion layer to contain zirconium (Col. 5 lines 60-66) or replace aluminum, as cited by Kim et al. above.

In regard to claims 2 and 7, where Dubin suggests that an adhesion layer can be deposited prior to a seed layer, in an alternative embodiment (Col. 7 lines 33-40).

In view of claim 13, Dubin depicts a via or hole structure (Fig. 1# 13b).

In view of claim 17, Dubin makes a metal interconnection buried in a dielectric layer having a barrier layer of tantalum nitride (TaN), an interconnect

layer using copper (Col. 6 lines 50-55), and an aluminum seed layer which can act as a adhesion layer to contain zirconium or replace aluminum. Then removes the top portion of the interconnect material (Fig. 2 & 3).

In view of claim 19, Kim et al. depicts a second layer of zirconium over the copper layer (Fig. 2 #48), which is not unusual in multi-level structures.

In view of claim 20, Dubin makes a metal interconnection buried in a dielectric layer having a barrier layer, an interconnect layer using copper (Col. 6 lines 50-55), and an aluminum seed layer which can contain zirconium. Then, conducts a low-temperature anneal to diffuse the atoms (Abstr.).

In view of claim 22, again Dubin makes a metal interconnection buried in a dielectric layer having a barrier layer of tantalum nitride (TaN), an interconnect layer using copper (Col. 6 lines 50-55), and an aluminum seed layer which can act as a adhesion layer to contain zirconium, then a chemical mechanical polishing (CMP) is done to the surface (Col. 6 lines 4-8).

In view of claim 26, Dubin suggests that many materials can be included in the metal materials (Col. 7 lines 40-46).

Claims 3-4, 8-12, 16, 18, 21 and 23-25, are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin (US. Pat.6,249,055) in view of Kim et al. (US. Pat. 4,751,349) and in further view of Venkatraman (US. Pat. 5,677,244).

Dubin discloses a metal interconnection buried in a dielectric layer having a barrier layer of tantalum nitride (TaN), an interconnect layer using

Art Unit: 2825

copper, and an aluminum adhesion layer. Kim et al. teaches that zirconium is the main element in a multi-layer metallic structure. Yet, neither inventor discloses an interconnection structure where islands are present. However, Venkatraman discloses a copper interconnection structure where islands are grown (Fig. 3). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the teachings of both inventors with the teachings of Venkatraman with the plan of achieving better adhesion results, since the film used to grow the islands of conductive material improve the adhesion of the filling material (Col. 1 line 65-Col. 2 line 5).

In view of claims 3, 8-9, 12, 16 and 25, Venkatraman shows a spacing of the island of 10 or more angstroms and are on the barrier layer (Col. 1 line 66-Col. 2 line 5).

In view of claims 4 and 18, Venkatraman tells how the islands are underneath the barrier layer (Col. 1 line 66-Col. 2 line 5) and between the barrier layer and the conductive layer (Fig. 2 & 3).

In view of claims 10-11 and 23-24 Venkatraman depicts an island with a thickness of 5-75 angstroms, similar to its diameter (Fig. 3).

In view of claim 21, Venkatraman depicts a low temperature annealing process to diffuse the atoms of the adhesion layer into the copper and other layers (Col. 5 lines 50-55).

Claims 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin in view of Kim et al. and in further view of Nogami et al. (US. Pat. 6,022,808).

Dubin discloses, as indicated, a metal interconnection buried in a dielectric layer having a barrier layer of tantalum nitride (TaN), an interconnect layer using copper, and an aluminum adhesion layer. Kim et al. teaches that zirconium is the main element in a multi-layer metallic structure to enhance adhesion. However, Dubin nor Kim et al. fail to suggest that a metal material having a solid solubility limit of 20% weight in copper or a resistivity increase of less than 19.8%. Nogami et al. teaches that in making an enhanced interconnection, a seed layer that is made of zirconium and when formed as an alloy should be 0.5 to 12 weight percent of copper (Col. 5 lines 10-33) and improve electro-migration resistance (Col. 5 lines 23-27). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the teachings of Dubin and Kim et al. with those of Nogami et al. with the anticipation of achieving superior electro-migration resistance, since this would lower resistance and achieve better conductivity (Col. 5 lines 13-27).

Response to Applicant's Arguments

The first argument regarding copper and the resistivity decrease, nearly all of the prior art discuss the use of copper and is well known in the art that electrical properties of the material are well established. Also well known is the

seed layer using zirconium, where adhesive factors are important. The arguments regarding Kim et al. and the use of an adhesion layer between a ceramic and metal, are not valid since a ceramic can be used as an insulator. The focus of the applicant's argument appears to be that although the same materials are used in making the device, and that the reason for using them is not explicitly taught. But in nearly all the prior art some indication is made to either better adhesive or conductive characteristics if not both. However, the arguments drawn to more quantitative values regarding the increase of electro-migration resistance or even thickness ratios are never claimed explicitly above the prior art.

Final Action

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP 706.07(a). Applicant is reminded of the extension of time policy as set forth in CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In

no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications for the examiner should be directed to Granvill Lee whose telephone number is (703) 306-5865. The examiner can be normally reached on Monday thru Thursday from 7:00 am to 5:30 pm.

If attempts to reach the examiner by telephone are not successful, the examiner's supervisor, Matthew Smith can be reached on (703) 308-1323. The fax phone number for this group is (703) 308-7722.

Any inquiry of a general nature relating to status or otherwise should be directed to the receptionist whose telephone number is 703-308-1782.

Examiner
Granvill Lee
Art Unit 2825

GI
5/24/01

C. Everhart
CARIDAD EVERHART
PRIMARY EXAMINER